International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 6, Issue 6, Dec 2016, 359-370

TRANS STELLAR
•Journal Publications •Research Consultancy

STUDIES ON DIFFERENT STOCKING DENSITIES ON PERFORMANCE AND ECONOMICS OF BROILER CHICKEN

R. D. MAREWAD, M. V. DHUMAL & M. G. NIKAM

Department of Poultry Science, College of Veterinary and Animal Science Parbhani,

Maharashtra Animal and Fishery Science University, Nagpur, Maharashtra, India

ABSTRACT

In order to evaluate the effect of different stocking on performance, litter quality and economics of broiler chicken, an experiment was carried out on by using 400 day old straight run chicks. The experiment was accomplished in completed randamised design including 5 treatments with four replicate and 25 birds per replicate. Treatment group A control with 1.0 sq.ft.area per bird, B with 1.2, C with 1.4 and D with 1.6 sq.ft.area per bird during finisher stage. The results revealed non-significant findings with cumulative body weight gain feed consumption, feed conversion ratio and mortality pattern. Highly significant differences were observed for litter moisture content among various treatment groups. There were non significant differences in weekly pH of litter material. The net profits per Kg live weight, the net profit per square feet area, broiler Performance Efficiency Index (BPEI) and European Productivity Index (EPI) were highest for treatment group A floor space @ 1 sq.ft/bird. Thus the present investigation concluded that increasing stocking density with decreasing floor space resulted into the best broiler performance.

KEYWORDS: Stocking Density, Floor Space, Broiler Performance, Economics, Litter Moisture and Litter PH

Received: Oct 28, 2016; **Accepted:** Nov 08, 2016; **Published:** Nov 22, 2016; **Paper Id.:** IJASRDEC201648

Original Article

INTRODUCTION

The proper stock density is essential for successful broiler production, profitability and welfare point of view. Assessing accurate stocking density, factors such as climate, housing types, ventilation systems, processing weight and welfare regulations must be taken into account. Keeping lee birds in the flock is one approach to maintain optimum density.

The optimum density is essential for better performance, however, only providing less space is not a alternative. Improved environmental factors along with space is utmost important. Many factors are responsible for deciding the optimum density like bird size, feeder space, drinker space, house dimension, nutrition, breed, birds welfare, performance, economics. The maximum broiler production per kilogram per square feet area production is achieved by providing optimum density and losses due to overcrowding are prevented. The stocking density is measured is recorded by number of birds per unit area or space per birds. Currently many companies /organizations calculate stocking density by the kilogram. However, the stocking density is as bird weight per unit area. Many recent studies revealed that improved strains of broilers perform better when more space is provided. However, the farmers are not able to afford more than one square area due to unsatisfactory return.

Commercial broiler owners rear the birds in high stocking density for achieving high profitability. However, this may results in higher mortality and lower weight gain. These adverse effects are due to lower air

flow, accumulation of ammonia, carbon monoxide etc. These effects are more pronounced in severe hot humid climatic. Hence, standard stocking density guidelines are needed for recent broiler strains.

The effects of high stocking density on body performance, mortality and some economic indexes of broilers reported to increase ammonia production, foot pad lesions, litter moisture, locomotion, heat stress and preening (8). Stocking density research reported in literature is limited on production parameters, meat yield, and litter quality of broilers grown to body weight of 2.5kg.

From the point, fast growing new strain of broiler and development of new standards, the present experiment was carried on effect of different stocking density on performance and economics of broiler chicken.

MATERIAL AND METHODS

Housing and Experimental Design

The experiment was carried out on 400 day old Vencobb-400 straight run commercial broiler chicks for a period of 42 days (6 weeks) from 14th January 2015 to 26th February 2015 in the Department of Poultry Science, College of Veterinary and Animal Sciences, MAFSU, Parbhani. The experimental design used in the present study for housing the broilers is presented in Table 1 and 2. However the details of percent ingredient composition has been given in Table 3

Table 1: Experimental Design Used for Housing of Broilers from 0 to 21st Days

Sr. No	Groups/Treatment	0 to 7 Days (20% Space)	8 to 14 Days (40% Space)	15 to 21 Days (40% Space)
1	**A**	0.20 sq. ft.	0.30 sq. ft.	0.40 sq. ft.
2	**B**	0.24 sq. ft.	0.36 sq. ft.	0.48 sq. ft.
3	**C**	0.28 sq. ft.	0.42 sq. ft.	0.56 sq. ft.
4	**D**	0.32 sq. ft.	0.48 sq. ft.	0.64 sq. ft.

Table 2: Experimental Design Used for Housing of Broilers from 22nd to 42nd Days

Treatment Group	Treatment Group Details	No. of Birds/Pen/ Replication	No. of Replication	Total Number of Birds
A	Control group; 1 sq.ft. Floor space per bird	25	4	100
B	Increase Floor space by 20% to reach 1.2 sq.ft.per bird	25	4	100
C	Increase Floor space by 40% to reach 1.4 sq.ft.per bird	25	4	100
D	Increase Floor space by 60% to reach 1.6 sq.ft.per bird	25	4	100
Total Number of Birds				**400**

The birds were randomly distributed with maintaining 50:50 sex ratios to form the experimental groups. The floor space was provided for all the treatment groups excluding feeding and drinking space. The same number of feeders and drinkers for all the experimental treatment groups were provided.

Table 3: Percent Ingredient and Nutrients Composition of Feed Starter, Grower and Finisher Ration of Broiler Chicken

Feed Ingredients	Starter (0-10d)	Grower (11-21d)	Finisher (22-42d)
Maize	53.2	54.0	58.5
Vegetable oil	3.0	4.2	4.9

Table 3: Contd.,			
Soya-bean meal	41.0	39.0	33.8
Dicalcium phosphate	1.5	1.5	1.5
Limestone powder	1.0	1.0	1.0
Salt	0.3	0.3	0.3
Total	100	100	100
Supplements/Additives (g/100kgs)			
*Mineral mixture	300	300	300
**Vitamin mixture	150	150	150
Methionine	180	190	160
Lysine	170	130	100
Choline chloride	60	60	60
Nutritional content (calculated) Crude protein (%)	23.08	22.24	20.22
Metabolizable energy (Kcal/kg)	3011.16	3100	3202.22
E:P ratio	130.46:1	139.38:1	158.37:1

*Mineral Mixture: - Copper, ferrous, zinc, iron.

**Vitamin Mixture: -Vit.A, D, E, K & Vit B Complex (Riboflavin, thiamine, Choline, pantothenic acid, niacin, pyridoxine, biotin, cynocobalamine).

The feed ingredients used in the present experiment were purchased from local market and rations were prepared as per (6) at Feed Mixing Plant, College of Veterinary and Animal Sciences, MAFSU, Parbhani. (Table 3)

Feeding and Watering Schedules

Weighed quantity of feed was offered to each replicate of treatment groups. The left over feed was collected and weighed separately on the first day morning of second week and onward of each week to arrive at the actual weekly feed consumption, which was inclusive of feed losses, if any. The birds were offered adlib fresh and clean drinking water throughout the experiment.

Data Collection

Data were collected on weekly weight changes was determined by weighing the birds on weekly basis and weight gain was calculated by subtracting the weight of the previous week from that of the current week. The feed intake was determined by subtracting the left-over feed from the feed offered, while feed conversion ratio was calculated as average feed intake divided by average /weight gain. The mortality was recorded daily and the weights of all the dead birds were taken in order to minimize an error in feed conversion ratio. It was expressed as percentage mortality at the end of the experiment for corresponding treatment group.

Moisture Percentage of Litter Material

The litter samples were collected from four locations within each pen. (Four peripheral, equidistant from each pen corner) and thoroughly mixed to obtain material representative of the entire pen. At least 200 gram of litter was placed in a plastic container and a subsample was taken for further analysis at the laboratory. The litter moisture samples were collected, mixing and obtaining a 100 gram litter subsample, placed in 15x30 cm tray and oven-dried for 48 hours at 60C. The percentage of moisture was calculated by using the weight loss between initial and dried litter (37) by using following formula.

$$\text{Moisture\%} = \frac{(\text{initial wt} - \text{dried wt})}{\text{initial wt}} \times 100$$

Where Wt = weight

Estimation of pH of Litter Material

The upper 10 cm of the litter was collected at each sample position for determination of pH. The pH of each sample was measured after litter samples of nearly 5 gram were suspended for 30 min in 25 ml of distilled water and stirred for 5 min using a pH meter (Mettler Toledo, GmbH, Switzerland, 25).

Economics of Broiler Production

The economics of broiler production was calculated by considering the cost of chick, total feed, litter, vaccine, medicine. However, the labour charges are not considered because the experiment was carried out by the student. The gross profit of broiler production per bird was calculated by subtracting the cost of production per bird from market price fetched on live weight basis.

Broiler Performance Efficiency Index

The index took into account total salable weight, feed efficiency as well as livability.

$$BPEI = \frac{\text{Total Saleble Live Weight (kg)}}{\text{No. of Chicks x Feed Efficiency}} \times 100$$

European Production Index

The index took into account average live weight, safety as well as feed consumption and total growing days.

$$EPI = \frac{\text{Average Live Weight (kg) x Safety \%}}{\text{Feed Consumption Per Kg of Gain x Term of Growing day}} \times 100$$

Statistical Analysis

All the generated data were subjected to statistical analysis (ANOVA) by using Complete Randomized Design (34). The treatment means were compared by critical differences (CD) and Analysis of Variance.

RESULTS AND DISCUSSIONS

Cumulative Weight Gain

The results of weight gain are presented in Table 4 & 5. The results showed that there were no significant differences in weight gain between the treatments in all ages. Non-significant results in regard to body weight gain of broiler in stocking density of 1, 1.2, 1.4 and 1.6 square feet per bird indicated increased creation of metabolic energy. An young broiler chickens can use for rapid growth, resulted increase in feed consumption and metabolism led to increased creation of heat (38). The weight gain observed in the present study with different floor space revealed the statistically non-significant differences amongst the treatment groups which may indicative of the fact that the increasing floor space per bird may not provide the required comfort zone for gaining the body weight with increasing floor space. However, the critical analysis of the numerical values of the cumulative weekly weight gain revealed the universally accepted fact and phenomenon of increasing stocking density with decreasing floor space (from 1.6 to 1.0 sq.ft. floor space per bird) resulted into the best performance in terms of body weight gains in the broilers. The results are similar in body weight gain of birds reared at different density (5) and found no differences in final body weight at 39 days of age with increasing stocking density. Similarly (26) reported that increase in population density in broiler chicken was not significantly influenced on the final mass of broilers. Similar findings were also reported by (19), (36) and (18). However, findings in the present

study are in contrast to the reports of many scientists (14,31,10,15, 31, 21,9 &22).

Table 4: Weekly Cumulative Weight Gain (g), Feed Consumption, FCR and Mortality at Different Age Groups with Different Stocking Density

Age (Weeks)	Groups/Treatments			
	Cumulative Weight Gain			
	A (1.0 Sq.ft.)	B (1.2Sq.ft.)	C (1.4Sq.ft.)	D (1.6 Sq.ft.)
I	113.88	117.72	114.55	122.77
II	355.45	362.72	360.18	372.00
III	752.84	746.62	749.06	762.25
IV	1256.73	1231.32	1234.96	1259.76
V	1849.99	1772.07	1797.21	1832.50
VI	2369.77	2315.77	2333.98	2331.92
Cumulative Feed Consumption				
I	136.63	136.76	136.91	140.80
II	440.20	440.26	440.71	445.10
III	985.21	983.29	985.65	995.70
IV	1769.32	1786.96	1776.06	1800.03
V	2735.81	2762.63	2749.89	2792.76
VI	3756.44	3763.17	3766.92	3805.63
Cumulative FCR				
I	1.20	1.16	1.20	1.17
II	1.24	1.21	1.22	1.20
III	1.31	1.32	1.32	1.31
IV	1.41	1.45	1.44	1.43
V	1.48	1.56	1.53	1.52
VI	1.59	1.62	1.61	1.63
	Mortality (%)			
Overall Mortality	**0**	**0**	**1**	**1**

Table 5: Analysis of Variance of Cumulative Weight Gain (g) of Broilers at Different Age Groups with Different Stocking Density

		Cumulative Weight Gain			Cumulative Feed Consumption			Cumulative FCR		
Source	DF	SS	M SS	F ratio	SS	MSS	F Ratio	SS	MSS	F Ratio
Groups	3	10638.846	3546.282	1.757	9172.946	3057.64	1.423	0.006	0.002	0.721
Weeks	5	59070600.	11814100.0	5853.4	159100000.00	31820000.00	14811.439	2.382	0.476	180.525
Error	87	175592.415	2018.304		186905.62	2148.341		0.230	0.003	
Total	**95**	**59256830.261**			**159286078.57**			**2.618**		

Cumulative Feed Consumption

The results of cumulative feed consumption are presented in Table 4&5. The results showed that there were no significant differences in feed consumption between the treatments in all ages. Statistically non-significant differences between the treatment groups indicating the fact that stocking density and floor space per bird (1 to 1.6 sq. ft. /bird) did not play any significant role in feed consumption. However, the critical observation of cumulative feed consumption in the present study revealed the fact that increasing floor space or decreasing stocking density increased the cumulative feed consumption. This may lead to the conclusion that increased floor space per bird engaged the bird only on concentrating feeding activity. This might have resulted in numerically increased feed consumption. These results in the present study

were similar to the findings reported by many scientists (28, 24,36, and 18). However, the present findings were in contrast to the finding (19),(21), (20), (35), they revealed that the feed consumption was influenced ($P < 0.01$) by stocking density.

Cumulative Feed Conversion Ratio (FCR)

The results of cumulative feed consumption are presented in Table 4 & 5. The statistically non-significant differences observed for cumulative feed conversion ratio amongst the different treatment groups provided with different stocking densities/ floor space. The critical observation of the weekly and cumulative feed conversion ratio did not reveal even the numerical differences which may lead to the strong conclusion that the broiler birds (Vencobb-400) must have a very good genetic potentiality of exhibiting most efficient feed conversion ratio ability even though they are subjected to different floor space and stocking densities when other managemental factors were at par. Better feed efficiency in higher stocking densities was established by (14), Similarly, (33) established better feed conversion ratio in all stages of broiler nutrition in higher stocking density. Absence of the effect of stocking density on feed conversion ratio was also concluded by (10).The numerous authors confirm non-significant effect of stocking density on feed conversion ratio. (29, 35,30,36 &18). Whereas, (19), (3), (24) revealed significant influence of stocking density on feed conversion ratio.

Mortality

The results of mortality are presented in Table 4 & 5.Non-significant influence of stocking density revealed that the space provided at 1.0 square feet per bird is optimum. The findings in accordance with present study were reported by (14), (29),(35),(24), & (30). In regard to mortality, majority of authors revealed non-significant differences of different stocking density, although it should not be overlooked that percentage of died broiler birds increases with the increase of stocking density (33), especially in stocking density below 1 square feet. In contrast to present study findings (20) showed significant increase of mortality with the increase of stocking density.

Moisture Percentage of Litter Material

The results of moisture percentage of litter material are presented in Table 7 & 8. Moisture percentage of litter material was significantly ($P<0.05$) influenced by stocking density in the present study. Significantly higher moisture percentage of litter observed for treatment group A provided with 1 square feet area compared to other treatment groups at the 6^{th} week of age. However, the moisture of litter was within ideal limit (20-25 %, 17). If litter moisture exceeds more than 25%, it will promote the proliferation of pathogenic bacteria and moulds and wet litter is also the primary cause of the high level of ammonia. Controlling litter moisture is most important step in avoiding ammonia problems (4). To limit ammonia production, litter moisture below 30% and temperature at the level of birds comfort is essential. In the present study the litter moisture was within optimum condition. The litter that is too dry and dusty can also leads to problems of respiratory diseases. Caked litter correspond to high litter moisture, litter becomes anaerobic. The moisture content of litter exceeding 35% is detrimental and correlated with higher fecal corticosteroid hormone which can increase the mortality. (7). The findings in the present study are in accordance with (10),(33),(29) & (30) revealed that litter moisture content of the groups were significantly affected by stocking density. However, (18) reported that, at 45 days of age, litter moisture did not differ statistically between two densities, in spite of the numerical differences in treatments.

Table 6: Weekly Moisture Percentage and pH of Litter Material with Different Stocking Density

Age (Weeks)	Treatment Groups			
	A) Moisture Percentage of Litter Material			
	A (1.0 Sq.ft.)	B (1.2Sq.ft.)	C (1.4Sq.ft.)	D (1.6 Sq.ft.)
I	5.85	5.59	5.77	5.57
II	26.25	32.45	28.49	26.57
III	32.47	29.45	26.69	27.77
IV	26.19	27.05	26.46	25.14
V	30.84	27.18	25.94	21.67
VI	32.08	21.49	23.55	20.90
B) pH of Litter Material				
I	6.23	6.26	6.25	6.27
II	5.96	5.71	5.86	5.91
III	5.62	6.41	6.29	5.88
IV	6.58	7.07	6.96	6.67
V	6.96	6.59	6.98	6.69
VI	7.07	6.78	6.67	6.53

Table 7: Analysis of Variance of Moisture Percentage and pH of Litter Material with Different Stocking Density

		Moisture Percentage of Litter Material			pH of Litter Material		
Source	**DF**	**SS**	**M SS**	**F ratio**	**SS**	**MSS**	**F ratio**
Groups	3	384.042	128.014	7.471**	0.728	0.243	1.758
Weeks	5	984.175	196.835	11.487**	17.025	3.405	24.677
Error	87	1490.776	17.135		12.005	0.138	
Total	**95**	**59256830.261**			**29.758**		

pH of Litter Material

The results of pH of litter material are presented in Table 7 & 8. A non-significant effect of stocking density on pH of litter material in the present study indicated ideal pH. To control ammonia production the litter pH should be below 7.0. In the present study pH of litter was within the ideal and normal limits. (29), (13) and (30) had revealed the significant to highly significant effect of increasing stocking density with the increased pH of litter material. It was in contrast to the present study where non-significant differences between treatment groups of stocking density were observed.

Economics of Broiler Production

The economics of broiler production from different treatment groups is presented in Table 9. The cost of day old chicks, feed, medication, vaccination, litter and other overheads were considered while calculating the cost of production. However, the costs of labour were not considered in calculating the cost of production of the broilers as this experiment being a postgraduate research work.

Table 8: Economics of Broiler Production at Different Stocking Density

Sr. No.	Particulars	Treatment Groups			
		A (1.0Sq.ft.)	B (1.2Sq.ft.)	C (1.4Sq.ft.)	D (1.6Sq.ft.)
1	Cost of day old chick (Rs)	20	20	20	20
2	Feed consumption (g)				
i)	Prestarter	501.44	503.17	500.92	505.63
ii)	Starter	1002.50	1005.20	1006.50	1010.35

Table 8: Contd.,

ii)	Finisher	2252.50	2254.80	2259.50	2289.65
	Total	**3756.44**	**3763.17**	**3766.92**	**3805.63**
3	Rate of feed (Rs/kg)				
i)	Prestarter	26.32	26.32	26.32	26.32
ii)	Starter	26.44	26.44	26.44	26.44
iii)	Finisher	25.59	25.59	25.59	25.59
4	Cost of feed consumed (per bird Rs.)				
i)	Prestarter	13.19	13.24	13.18	13.30
ii)	Starter	26.50	26.57	26.61	26.71
iii)	Finisher	57.64	57.70	57.82	58.59
	Total Cost of Feed Consumed per Bird (Rs.)	**97.33**	**97.51**	**97.61**	**98.60**
5	Miscellaneous cost* (Rs)	5	5	5	5
6	Total cost of production (1+4+5)	122.33	122.51	122.61	123.60.
7	Average live weight (g)	2405.87	2351.76	2370.03	2367.92
8	Return obtained @ Rs. 58 per kg live weight	139.54	136.40	137.46	137.34
9	Net Profit/Bird (Rs.)	17.21	13.89	14.85	13.74
10	Net profit/ kg (Rs)	7.15	5.90	6.26	5.80
11	Net profit per sq.ft area	17.21	11.58	10.61	8.59
12	Broiler performance efficiency index(BPEI)	175.61	169.31	169.17	170.37
13	European Productivity Index (EPI)	418.12	403.13	402.78	405.63

Significant findings in the present study for net profit per bird, net profit per kg, net profit per square feet area, broiler performance efficiency index (B.P.E.I.) and Europian productivity index (E.P.I.) for treatment group A compared to rest of the treatment groups concluded that higher live body weight in broiler maintained under less floor space increased the profitability. The research findings in the present study were in accordance with (23), they revealed that reduction in final stocking density caused drop in net income from broiler production. The profitability enhanced with increased stocking density (30). It may be due to reduction of fixed cost and more kilogram production of broiler per area.

CONCLUSIONS

Based on present study, it is concluded that a limitation of floor space for broiler farming should go for high density (1 square feet area per bird) with precise system for ventilation that could effectively used for soothing the bird's micro climate. When the poultry farmer's focus is on body size and body weight rather than number and keeping birds more than 45 days they should opt low bird density (1.2 square feet area per bird). The economics of broiler observed in present study concluded that direct and proportionate correlation of increasing floor space with decreasing profit in all aspects of profit calculation which may strongly lead to the conclusion that 1 sq. ft./ bird floor space is the most ideal and realistic in all respects of broiler production.

AKNOWLEDGEMENTS

The authors are highly grateful to S B Majee, Associate Dean, College of Veterinary and Animal Sciences, MAFSU, Parbhani for providing necessary facilities and help at various stages of the experiment.

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